



Pedi Crisis CRITICAL EVENTS CHECKLISTS

For use in the peri-anesthesia setting

Revision March 2023. TOC Jan 2023. Formatted June 2020. Available at <https://pedsanesthesia.org/checklists/>

1	Air Embolism
2	Anaphylaxis
3	Anterior Mediastinal Mass
4	Bradycardia
5	Bronchospasm
6	Cardiac Arrest: Pulseless VF/VT, PEA, Asystole
7	Chest Compressions: Supine/Prone
8	Difficult Airway
9	Fire: Airway
10	Fire: OR (Non-airway)
11	Hyperkalemia
12	Hypertension, Acute
13	Hypotension
14	Hypoxia

Call for help!

Code Team _____
 PICU _____
 Fire _____
 Overhead STAT _____
 ECMO _____

Notify surgeon/team

15	Intracranial Pressure
16	Laryngospasm
17	Local Anesthetic Toxicity
18	Loss of Evoked Potentials
19	Malignant Hyperthermia
20	Massive Hemorrhage
21	Myocardial Ischemia
6	PEA
22	Pulmonary Hypertension
23	Status Epilepticus
24	Tachycardia, unstable/SVT
25	Tamponade, Cardiac
26	Tension pneumothorax
27	Transfusion Reaction
28	Trauma
29	Maternal OB Hemorrhage

Use expert clinical judgment when using this and all emergency manuals.

- Notify team, stop nitrous oxide and volatile agents. Increase O₂ to 100%
- Stop air entrainment: Find air entry point, stop source, and limit further entry
- Ask surgeon:
 - Flood wound with irrigation/soaked saline dressing
 - Stop all pressurized gas sources, e.g. laparoscope, endoscope
 - Place bone wax or cement on exposed bone edges
- Check for open venous lines or air in IV tubing
- Position surgical site below heart, head down, lateral (if possible)
- Consider:
 - Compress jugular veins intermittently if head or cranial case
- If hypotensive:
 - Give EPINEPHrine 1-10 MICROgrams/kg IV, consider infusion EPINEPHrine 0.02-1 MICROgrams/kg/min IV or NOREPInephrine 0.05-2 MICROgrams/kg/min IV
 - Chest compressions: 100-120/min to force air through lock, even if not in cardiac arrest
 - If available, call for TEE/US. Consider ECMO
- If cardiac arrest, see 'Cardiac Arrest' card
- Consider Differential (Partial)
 - Embolus (fat, thrombotic, cement, amniotic fluid)
 - Anaphylaxis
 - Local anesthetic systemic toxicity



- Increase O₂ to 100%, evaluate ventilation
- Remove suspected trigger(s)
 - If latex is suspected, thoroughly wash area
- If HYPOtensive, turn off anesthetic agents

Common causative agents:

- Neuromuscular blockers
- Latex
- Chlorhexidine
- IV colloids
- Antibiotics

Indications	Treatments
To restore intravascular volume	NS or LR, 10-30 mL/kg IV/IO, rapidly
To increase BP and reduce mediator release	<ul style="list-style-type: none">▪ EPINEPHrine 1-10 MICROgrams/kg IV/IO, as needed or 10 MICROgrams/kg IM q5-15 min as needed▪ May need EPINEPHrine infusion 0.02-1 MICROgrams/kg/min IV▪ If BP remains low, give Vasopressin 10 MILLIunits/kg IV
To reduce histamine-mediated effects	DiphenhydrAMINE 1 mg/kg IV/IO (MAX 50 mg) or Famotidine 0.25 mg/kg IV (MAX 20 mg)
To reduce mediator release	MethylPREDNISolone 2 mg/kg IV/IO (MAX 100 mg)
To reduce bronchoconstriction	Albuterol (Beta-agonists) 4-10 puffs, repeat as needed

- Send tryptase within 3 hours
- Consider Differential (partial):
 - Severe bronchospasm from URI or underlying condition: go to 'Bronchospasm' card
 - Air, fat, thrombotic, or cement embolus: go to 'Air Embolism' card
 - Sepsis: support BP, antibiotics

Intra-operative Treatments

Airway Collapse

- Increase O₂ to 100%
- Increase FiO₂
- Add CPAP for spontaneous ventilation; add PEEP for controlled ventilation
- Reposition to lateral or prone
- Ventilate via rigid bronchoscope

Cardiovascular Collapse

- Increase O₂ to 100%
- Give fluid bolus
- Reposition to lateral or prone
- Ask surgeon for sternotomy and elevation of mass
- Consider ECMO

Preoperative Considerations

High Risk Factors

- Etiology:
 - Hodgkin's and non-Hodgkin's lymphoma
- Clinical signs:
 - Orthopnea, upper body edema, stridor, wheezing
- Imaging findings:
 - Tracheal, bronchial, carinal, or great vessel compression; SVC or RVOT obstruction; ventricular dysfunction; pericardial effusion

Anesthetic Plan

- Perform surgery under local anesthesia, if possible
- Pre-treat with irradiation or corticosteroids
- Maintain spontaneous ventilation and avoid paralysis
- Ensure availability of fiberoptic and rigid bronchoscope
- Cardiopulmonary bypass or ECMO
- Type and cross and sternal saw (for surgeons) available

Definition:

Age < 30 days	HR < 100
≥ 30 days < 1 yr	< 80
≥ 1 yr	< 60

- If hypotensive, pulseless, or poor perfusion: start chest compressions. See 'Cardiac Arrest' card
 - Give EPINEPHrine 10 MICROgrams/kg IV
 - Call for transcutaneous pacer (see inset)
 - Start pacing, when available
- Confirm NSR. If heart block or slow junction/ventricular, call EP
- If NOT hypotensive or pulseless:

Etiology	Treatment
Hypoxia (most common)	<ul style="list-style-type: none"> ■ Increase O₂ to 100% ■ Ensure ventilation ■ See 'Hypoxia' card
Vagal	<ul style="list-style-type: none"> ■ Atropine 0.01-0.02 mg/kg IV
Surgical Stimulation	<ul style="list-style-type: none"> ■ Stop stimulation ■ If laparoscopy, desufflate
Ca-Channel Blocker Overdose	<ul style="list-style-type: none"> ■ Calcium chloride 10-20 mg/kg IV or Calcium gluconate 50 mg/kg IV ■ If ineffective, Glucagon as dosed below
Beta-Blocker Overdose	<ul style="list-style-type: none"> ■ Glucagon 50 MICROgrams/kg IV, then 0.07 mg/kg/hour IV infusion (MAX 5 mg/hr) <ul style="list-style-type: none"> • Check blood sugar

Instructions for PACING

1. Place pacing ECG electrodes AND pacer pads on chest per package instructions
2. Turn monitor/defibrillator ON, set to PACER mode
3. Set PACER RATE (ppm) to desired rate/min. (Can be adjusted up or down based on clinical response once pacing is established)
4. Increase the milliamperes (mA) of PACER OUTPUT until electrical capture (pacer spikes aligned with QRS complex; threshold normally 65-100mA)
5. Set final mA to 10mA above this level
6. Confirm pulse is present
7. Must change pacing pads hourly to avoid burns

Bronchospasm

↓ EtCO₂, upslope stage III EtCO₂
↑ airway pressures, ↓ SpO₂

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Bronchospasm

Revision Oct 2018

Intubated Patient	Non-Intubated Patient
<ul style="list-style-type: none"> ▪ Increase FiO₂ to 100% ▪ Auscultate the chest: <ul style="list-style-type: none"> • Equal breath sounds? • Endobronchial ETT? • Wheezing? ▪ Check ETT: <ul style="list-style-type: none"> • Kinked? • Secretions/blood in ETT? Needs suctioning? ▪ Consider albuterol 2-10 puffs, repeat as needed ▪ Consider deepening anesthetic ▪ If needed, give ketamine 1-2 mg/kg IV ▪ If severe, consider EPINEPHrine 1-2 MICROgrams/kg IV (MAX 1 mg) ▪ Consider IV steroids: methylprednisolone 2 mg/kg IV (MAX 60 mg) or dexamethasone 0.15-0.25 mg/kg (MAX 16 mg) ▪ Consider chest radiograph ▪ For refractory bronchospasm, consider magnesium sulfate 50-75 mg/kg (MAX 2 grams) bolused over 20 minutes, (CAUTION, may cause hypotension) 	<ul style="list-style-type: none"> ▪ If ETT in, go to 'Intubated Patient' column on this card (at the left) ▪ Administer supplemental oxygen ▪ Auscultate the chest, differentiate from stridor/extrathoracic airway obstruction ▪ Consider inhaled albuterol (with spacer) 2.5-5 mg. If severe, 5-20 mg/hr inhaled ▪ Consider chest radiograph ▪ Consider IV steroids: methylprednisolone 1 mg/kg IV (MAX 60 mg) or dexamethasone 0.15-0.25 mg/kg (MAX 16 mg) ▪ If severe, consider EPINEPHrine 1-2 MICROgrams/kg IV (MAX 1 mg) or 10 MICROgrams/kg subcutaneous/intramuscular (MAX 0.5 mg) ▪ If severe, consider ICU and/or advanced airway management.
Differential Diagnosis	
<ul style="list-style-type: none"> ▪ Endobronchial intubation ▪ Mechanical obstruction of ETT <ul style="list-style-type: none"> • Kinking • Solidified secretions or blood • Overinflation of tracheal tube cuff ▪ Inadequate depth of anesthesia ▪ URI/tobacco exposure ▪ Foreign body 	<ul style="list-style-type: none"> ▪ Pulmonary edema ▪ Tension pneumothorax ▪ Aspiration pneumonitis ▪ Pulmonary embolism ▪ Persistent coughing and straining ▪ Asthmatic attack ▪ Anaphylaxis

Cardiac Arrest: Pulseless VF/VT, PEA, Asystole

Pulseless
cardiac arrest

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- Notify team, designate team leader, call for help and code cart/defibrillator
- Increase O₂ to 100%. Turn off anesthetics. Start timer
- If ETT, 100-120 chest compressions/min + 10 breaths/min. Avoid hyperventilation
- If no ETT, 15:2 compression:ventilation ratio (100-120 chest compressions/min + 8 breaths/min)
- For chest compressions, maximize EtCO₂ > 10 mmHg (see next card for more details):
 - Switch compressor every 2 min
 - Use sudden increase in EtCO₂ for ROSC, Do NOT stop compressions for pulse check
- Obtain defibrillator. **Attach pads.** If VF/VT, shock 2 joules/kg. Continue chest compressions for 2 minutes
- Assign roles. Designate a scribe/recorder. Notify family. Continue with items in yellow box

Repeat sequence below until return of spontaneous circulation:

- If still in VF/VT, shock 4 joules/kg q2 min (up to 10 joules/kg on subsequent shocks)
- Resume chest compressions immediately regardless of rhythm
- EPINEPHrine 10 MICROgrams/kg IV q 3-5 min while in arrest (MAX 1 mg)
 - If still no ROSC after second dose of EPINEPHrine, **activate ECMO** (if available)
- Check pulse & rhythm q 2 min during compressor change
- Check for reversible causes (Hs and Ts) early and often (see table below)
- Lidocaine 1 mg/kg bolus (MAX 100 mg); may repeat (total: 2 doses) **OR** amiodarone 5 mg/kg bolus; may repeat (total: 3 doses)
- Repeat sequence in this box until return of spontaneous circulation

Hs and Ts: Reversible Causes

- Hypovolemia
- Hypoxemia
- Hydrogen ion (acidosis)
- Hyperkalemia/Hypoglycemia
- Hypothermia

- Tension Pneumothorax
- Tamponade (Cardiac)
- Thrombosis
- Toxin (anesthetic, β -blocker)
- Trauma (surgical or nonsurgical bleeding)

Chest Compressions: Supine / Prone

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- Chest compression instructions (see previous card for full CPR instructions):
 - Place patient on backboard, maintain good hand position; if prone, see instructions below
 - Maximize EtCO₂ > 10 mmHg with force/depth of compressions
 - Allow full recoil between compressions
 - Switch compressor every 2 min
 - Use sudden increase in EtCO₂ for ROSC, Do NOT stop compressions for pulse check

Prone: Children/Adolescents

- **If no midline incision:**

Compress with heel of hand on spine and second hand on top

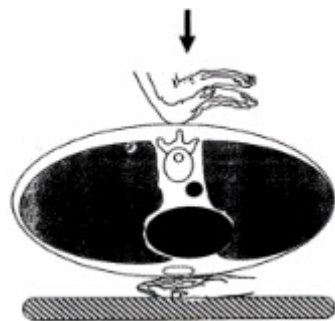


Figure 1

- **If midline incision:**

Compress with heel of each hand under scapula



Figure 2

Prone: Infants

Compress with encircling technique:

- **If no midline incision:**

thumbs midline

- **If midline incision:**

thumbs lateral to incision



Figure 3

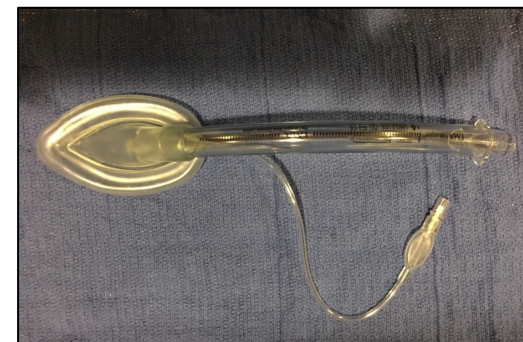
Figure 1: From Dequin P-F et al. Cardiopulmonary resuscitation in the prone position: Kouwenhoven revisited. Intensive Care Medicine, 1996;22:1272

Figure 2: From Tobias et al, Journal of Pediatric Surgery, 1994;29, 1537-1539

Figure 3: Original artwork by Brooke Albright-Trainer, MD

Difficult Airway, Unexpected

- Increase O₂ to 100% and maintain continuous oxygen flow during airway management
- Call for help, surgical airway expert and cart, rigid bronchoscope and tracheostomy kit
- If unable to mask ventilate, ask for 2-handed assistance and:
 - Insert oral and/or nasal airway
 - If unsuccessful, insert supraglottic airway (e.g., LMA)
 - Decompress stomach with orogastric tube
 - Consider reversing rocuronium or vecuronium with sugammadex (16 mg/kg). Call to obtain if not in OR.
- If able to re-establish pt spontaneous ventilation:
 - Consider awakening patient
 - Consider reversal of neuromuscular blocker
- After two attempts: change providers, position, and blade, consider alternate approaches (see table)
- If macroglossia (e.g. Beckwith-Wiedemann, Pierre-Robin), or mediastinal mass, consider prone or lateral position
- If still unable to ventilate, consider:
 - Rigid bronchoscopy
 - Jet ventilation
 - Emergency invasive/surgical airway such as cricothyrotomy or tracheostomy (Note: difficult in infants)



Alternative Approaches for Intubation

- Video-laryngoscope
- Bougie
- Intubating LMA
- Fiberoptic scope
- Intubating stylet
- Blind oral
- Blind nasal

- Simultaneously:
 - Disconnect circuit from tracheal tube then remove tracheal tube
 - Stop all gas flow (O_2 , N_2O)
 - Remove sponges and other flammable materials from airway
 - Pour saline into airway
- Re-intubate and re-establish ventilation
 - If intubation difficult, don't hesitate to obtain surgical airway
- Consider bronchoscopy to assess for thermal injury
 - Look for tracheal tube fragments
 - Remove residual material
- Impound all equipment and supplies for later inspection
- Maintain ventilation. Assess for inhalation injury
- Consider input from ENT, pulmonary, plastic surgery
- Consider PICU
- Shut off gases to affected OR if fire not self-contained
 - Verify gases are not shut off to adjacent rooms



Picture from ECRI: www.ecri.org

- Simultaneously:
 - Stop flow of medical gases
 - Remove drapes and all burning and flammable material from patient
 - Make one attempt to extinguish fire by pouring saline on fire
- If fire not extinguished on 1st attempt, use CO₂ fire extinguisher
- If fire persists:
 - **Activate fire alarm**
 - Remove patient from OR
 - Confine fire by closing all OR doors
 - Turn off O₂ gas supply to OR
- Maintain ventilation. Assess for inhalation injury
- Consider input from ENT, pulmonary, plastic surgery
- Consider PICU
- Shut off gases to affected OR if fire not self-contained
 - Verify gases are not shut off to adjacent rooms
- Impound all equipment and supplies for later inspection



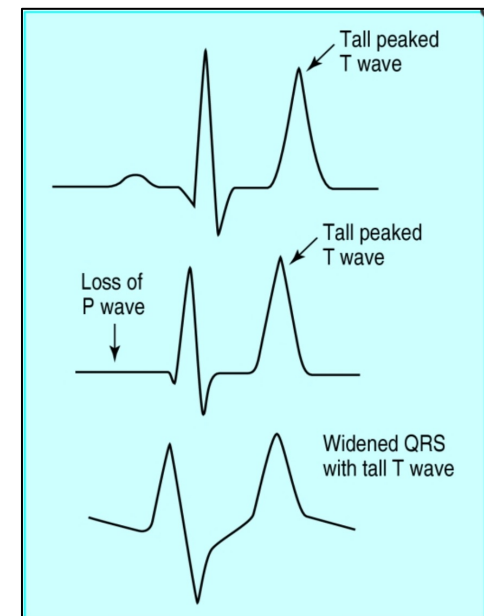
Picture from ECRI: www.ecri.org

Treatment:

- If hemodynamically unstable, start CPR/PALS
- Hyperventilate with 100% O₂
- Calcium gluconate 60-100 mg/kg or calcium chloride 20 mg/kg IV
 - Directly visualize site to avoid infiltration
 - Flush tubing after calcium administration
- Stop K+ containing fluids (LR/RBC); switch to NS
- Dextrose IV 0.5-1 g/kg and insulin IV 0.1 Unit/kg (MAX 10 units)
- Albuterol puffs or nebulized, once cardiac rhythm stable
- Sodium bicarbonate IV 1-2 mEq/kg
- Furosemide IV 0.5-1 mg/kg
- Consider terbutaline 10 MICROgrams/kg load, then 0.1-10 MICROgrams/kg/min
- If cardiac arrest > 6 min, activate ECMO (if available)
- Dialysis if refractory to treatment
- If transfusion required, use washed or fresh RBC

Manifestations:

- Tall peaked T wave
- Heart block
- Sine wave
- V fib or asystole



From: Slovis C, Jenkins R. BMJ 2002

Causes of Hyperkalemia:

- Excessive intake: massive or “old” blood products, TPN, cardioplegia, KCl infusion
- Shift of K+ from tissues to plasma: crush injury, burns, succinylcholine, malignant hyperthermia, acidosis
- Inadequate excretion: renal failure
- Pseudohyperkalemia: hemolyzed sample, thrombocytosis, leukocytosis

Hypertension, Acute

Sustained high blood pressure refractory to treating reversible causes

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Hypertension, Acute

- In pediatrics, hypertension is almost always treated by addressing likely causes such as light anesthesia or measurement error:
 - Ensure correct BP cuff size: cuff bladder width ~ 40% of limb circumference
 - Ensure arterial line transducer is at level of heart
 - Consider placing arterial line if not already present

Hypertensive Blood Pressure Range*		
Age (yr)	Systolic	Diastolic
newborn	>97	>70
1-3	>105	>61
4-12	>113	>86

- * **CAUTION:** Anti-hypertensive drugs are almost never needed for routine pediatric cases. These medications are used almost exclusively for specialized cardiac, neurosurgical, or endocrine (pheochromocytoma) cases. Consult an expert before use. Rule-out increased ICP.

Action	Drug (IV Dosing)
Direct smooth muscle relaxation	<ul style="list-style-type: none">■ Sodium nitroprusside 0.5-10 MICROgrams/kg/min■ HydrALAZINE 0.1-0.2 mg/kg (adult dose 5-10 mg)
β-Adrenergic blockade	<ul style="list-style-type: none">■ Esmolol 100-500 MICROgrams/kg over 5 min, then 25-300 MICROgrams/kg/min■ Labetalol (also α effect) 0.2-1 mg/kg q 10 min; 0.4-3 mg/kg/hour (infusion)
Calcium channel blockade	<ul style="list-style-type: none">■ niCARdipine 0.5-5 MICROgrams/kg/min■ Clevidipine 0.5-3.5 MICROgrams/kg/min
D1-dopamine agonist	<ul style="list-style-type: none">■ Fenoldopam 0.2-0.8 MICROgrams/kg/min

- Consider Differential (Partial):
 - Light anesthesia (consider vaporizer or infusion pump empty or malfunctioning)
 - Hypoxemia
 - Thyroid Storm
 - Hypercarbia
 - Arterial line transducer too low or BP cuff too small
 - Pheochromocytoma
 - Withdrawal (EtOH or opioid)
 - Drug Error

Hypotension

Sustained low blood pressure with patient at risk for end-organ hypoperfusion, typically > 20% below baseline

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- Ensure oxygenation/ventilation
- Turn anesthetic agents down or off
- Check cuff size and transducer position
- Consider placing arterial line
- Give appropriate treatment (see table below)

Age	BP (mmHg)*	
infant	MAP 30 or post-conceptual age in weeks	
3 mo – 1 yr	65 – 68	< 5 th % Systolic BP
1 – 3 yr	68 – 74	
4 – 12 yr	70 – 85	
> 12 yr	85 – 92	

* Numbers are only a guide and vary by patient and situation

	↓ Preload	↓ Contractility	↓ Afterload
Causes	<ul style="list-style-type: none"> ▪ Hypovolemia/hemorrhage ▪ Vasodilation ▪ Impaired venous return ▪ Tamponade ▪ IVC compression (prone, obese, surgical) ▪ Pneumothorax/pneumoperitoneum/PE ▪ Increased PIP or PEEP 	<ul style="list-style-type: none"> ▪ Negative inotropic drugs (anesthetic agents) ▪ Arrhythmias ▪ Hypoxemia ▪ Heart failure (ischemia) ▪ Hypocalcemia/blood product administration 	<ul style="list-style-type: none"> ▪ Drug-induced vasodilation ▪ Sepsis ▪ Anaphylaxis ▪ Adrenal crisis ▪ Hypocalcemia ▪ Thyroid crisis
Treatment	<ul style="list-style-type: none"> ▪ Expand circulating blood volume (administer fluids rapidly, consider PRBCs and albumin) ▪ Trendelenberg position ▪ Place or replace IV; consider intraosseous line 	<ul style="list-style-type: none"> ▪ Start inotrope if needed: DOPamine 2-20 MICROgrams/kg/min IV infusion, or EPINEPHrine 1-10 MICROgrams/kg IV bolus then EPINEPHrine 0.02-1 MICROgrams/kg/min IV infusion ▪ Calcium chloride 10-30 mg/kg IV or Calcium gluconate 50 mg/kg IV ▪ Review ECG (rhythm, ischemia), send ABG, Hgb, electrolytes 	<ul style="list-style-type: none"> ▪ Start vasopressor if needed: phenylephrine 1-20 MICROgrams/kg IV bolus, then phenylephrine 0.1-2 MICROgrams/kg/min IV infusion, or norepinephrine 0.05-2 MICROgrams/kg/min IV infusion ▪ Go to 'Anaphylaxis' card, if appropriate. ▪ Administer steroids for adrenal crisis

- Turn FiO₂ to 100%
- Confirm presence of end-tidal CO₂, look for any changes in capnogram
- Hand-ventilate to assess compliance
- Listen to breath sounds
- Consider DOPE: displacement, obstruction, pneumothorax, equipment failure
- Check:
 - ETT tube position and patency. Correct if mainstem or supraglottic, suction to rule out mucous plug, secretions, or kink
 - Consider circuit integrity: kink in circuit or ETT, bronchospasm, obstruction, mucous plug
 - Pulse oximeter: try new probe or changing placement
 - Check BP and HR
 - Consider recruitment maneuvers
 - Consider deepening anesthetic or muscle relaxant if patient-ventilator asynchrony
- Further assessment: Draw blood gas. Perform bronchoscopy, CXR, TEE, ECG
- Consider Differential Diagnosis. If airway cause suspected, see appropriate table below

YES, Airway Cause IS Suspected

Lungs

- Bronchospasm/atelectasis
- Aspiration
- Pneumothorax
- Pulmonary Edema

ETT

- Mainstem intubation
- Mucous Plug
- ETT kinked or dislodged

Machine

- Ventilator settings: RR, TV, I:E ratio, auto-PEEP
- Machine malfunction

NO, Airway Cause is NOT Suspected

Drugs/Allergy

- Recent drugs given
- Allergy / anaphylaxis (see 'Anaphylaxis' card)/dose error
- Methylene blue/dyes or methemoglobinemia

Circulation

- Embolism – air (see 'Air Embolus' card), fat, CO₂, pulmonary, septic, MI, CHF, cardiac tamponade
- Severe sepsis
- Right to left intracardiac or intrapulmonary shunt
- If associated with hypotension, see 'Hypotension' card

- If GCS < 9, respiratory distress, hemodynamic instability:
 - Secure airway
 - Provide sedation prior to transport
- Keep PaCO₂ 30-35 mmHg and PaO₂ > 80 mmHg
- Maintain cerebral perfusion pressure (discuss goal CPP with team)
- Discuss target ICP with neurosurgery, will often want ICP < 20
- Use vasopressors (phenylephrine or NOREPinephrine) as needed to maintain BP and CPP.
- Consider head of bed at 30°
- Hypertonic saline (3% saline via central venous catheter) 1-5 mL/kg over 20 min, then 0.1-2 mL/kg/hour; goal ICP <20 mmHg
 - Monitor serum sodium
 - Keep osmolarity <360 mOsm/L
- If hypertonic saline not available, can give mannitol 0.25-1 g/kg, over 20 minutes to decrease ICP
- Consider furosemide 1-2 mg/kg (starting MAX 20 mg) to decrease ICP
- Consider seizure prophylaxis: Keppra (levetiracetam) 10-30 mg/kg IV (MAX 2500 mg)
- Consult with neurosurgery colleagues about draining CSF directly or via ventriculostomy
- Refractory elevated ICP treatment, consider:
 - Barbiturate coma
 - Paralysis with non-depolarizing agent
- **AVOID:**
 - Compression of neck vessels
 - Hyperthermia
 - Hyperglycemia & dextrose containing solutions (maintain glucose level < 200 mg/dL)

MAP to optimize CPP	
Age (yrs)	MAP
0-4	>45
5-8	>55
>8	>60

Signs and Symptoms

- Inspiratory stridor, accessory muscle use, sternal retractions, paradoxical chest movement, airway obstruction, ↓SpO₂, ↓HR, loss of EtCO₂

Treatment

- Notify team to cease stimulation/surgery
- Give 100% O₂, evaluate ventilation
- Apply CPAP and jaw thrust
- Confirm or establish adequate IV access
- Deepen anesthesia with IV and/or inhaled agents. Consider propofol 1-3 mg/kg
- Give succinylcholine 0.1-2 mg/kg (if no IV: 2-4 mg/kg IM)
- If bradycardia, give atropine 0.02 mg/kg IV (if no IV: 0.04 mg/kg IM)
- Consider direct laryngoscopy to secure the airway and/or suction
- Avoid further patient stimulation during stage 2 anesthesia
- If further airway instrumentation needed, consider airway topicalization with lidocaine
- Monitor for negative pressure pulmonary edema (pink frothy secretions). If present, consider ETT, PPV, PEEP, ICU

Differential Diagnosis

- Circuit disconnect or obstruction
- Upper airway obstruction
- Lower airway obstruction/bronchospasm

- Stop local anesthetic
- Request Intralipid kit
- Secure airway and ventilation
- Give 100% O₂
- Confirm or establish adequate IV access.
- Confirm & monitor continuous ECG, BP, and SaO₂
- Seizure treatment:
 - Midazolam 0.05-0.1 mg/kg IV
 - Be prepared to treat resultant hypoventilation
- Treat hypotension with small doses of EPINEPHrine 1 MICROgram/kg
- **Avoid** propofol, vasopressin, calcium channel blockers and beta blockers
- Start Intralipid therapy (see inset box)
- If cardiac instability occurs:
 - Start CPR/PALS
 - Continue chest compressions (lipid must circulate). May need prolonged compressions
- Consider: alert nearest cardiopulmonary bypass/ECMO center & ICU if no ROSC after 6 min
- Monitor and correct acidosis, hypercarbia and hyperkalemia
- Monitor for recurrence for 4-6 hours following the event
- Consider Differential (partial):
 - Anaphylaxis: go to Anaphylaxis card
 - Air, fat, thrombotic, or cement embolus: go to Air Embolism card

Intralipid Dosing

- Bolus Intralipid 20% 1.5 mL/kg over 1 min
- Start infusion 0.25 mL/kg/min
- Repeat bolus every 3-5 min up to 4.5 mL/kg total dose until circulation is restored
- Double the rate to 0.5 mL/kg/min if BP remains low
- Continue infusion for 10 min after hemodynamic stability is restored.
- MAX total Intralipid 20% dose: 10 mL/kg over first 30 min

- Notify all members of health care team. Call a “time out”
- Loss of evoked potentials (EP) requires definitive steps to re-establish perfusion/remove mechanical cause; MEP loss for > 40 min may increase possibility of long term injury
 - Assure the presence of attending surgeon, attending anesthesiologist, senior neurologist or neurophysiologist, and experienced nurse
 - Each service: review situation, report on management and corrective actions taken
 - Surgeon: rule out mechanical causes for loss/change including traction weights
 - EP technologist: rule out technical causes for loss/change
 - Anesthesiologist: assure no neuromuscular blockade is present; reverse NMB if necessary
- Check patient positioning (neck, upper and lower extremities)
- Review the anesthetic and consider improving spinal cord perfusion by modifying:
 - Mean arterial pressure: MAP > 65 mmHg using ePHEDrine 0.1 mg/kg IV (MAX 10 mg/dose) and/or phenylephrine 0.3-1 MICROgrams/kg IV (MAX 100 MICROgrams/dose), with repeated doses as needed
 - Hemoglobin: if anemic, transfuse RBC to improve oxygen delivery
 - pH and PaCO₂: ensure normocarbida or slight hypercarbia (↑ I/E ratio, ↓ PEEP)
 - Temperature: ensure normothermia
 - Check for “unintended” drugs given (e.g. neuromuscular blocker)
 - Decrease depth of anesthetic and ensure N₂O is under 50%
- Discuss feasibility of a useful wake-up test:
 - Patient is appropriate candidate if capable of following verbal commands
- Consider high-dose steroid if no improvement:
 - MethylPREDNISolone 30 mg/kg IV over one hour, then 5.4 mg/kg/hour IV for 23 hours

MH hotline 1-800-644-9737

- Get MH Cart, dantrolene, and help
- Notify team and stop procedure, if possible
- Stop volatile anesthetic, succinylcholine.
- Attach charcoal filter. Turn O₂ flow to 10 L/min
- Hyperventilate patient to reduce EtCO₂
- Give dantrolene 2.5 mg/kg IV, rapidly, through large bore IV if possible, every 5 min until symptoms resolve. May need up to 10 mg/kg (if no response at this dose, consider alternative diagnoses)
 - Dantrium/Revonto: Assign dedicated person to mix these formulations of dantrolene (20 mg/vial) with 60 mL non-bacteriostatic sterile water
 - Ryanodex: 250 mg is mixed with 5 mL non-bacteriostatic sterile water
- Transition to non-triggering anesthetic
- Give sodium bicarbonate 1-2 mEq/kg IV for suspected metabolic acidosis
- Cool patient:
 - Apply ice externally to axilla, groin and around head
 - Infuse cold saline intravenously
 - NG and open body cavity lavage with cold water
 - Stop cooling when temperature < 38° C
- Hyperkalemia treatment:
 - Calcium gluconate 30 mg/kg IV or calcium chloride 10 mg/kg IV;
 - Sodium bicarbonate 1-2 mEq/kg IV;
 - Regular insulin 0.1 units/kg IV (MAX 10 units) and dextrose 0.5-1 g/kg IV
- VT or afib treatment: Do NOT use calcium channel blocker; give amiodarone 5 mg/kg
- Send labs: ABG or VBG, electrolytes, serum CK, serum/urine myoglobin, coagulation
- Place urinary catheter, maintain UO > 2 ml/kg/hr
- If cardiac arrest occurs, begin CPR & consider ECMO, see 'Cardiac Arrest' card
- If no response after 10 mg/kg dantrolene, consider other dx: sepsis, NMS, serotonin synd., myopathy, pheochromocytoma
- Call ICU to arrange disposition. For post-acute management, see: <http://www.mhaus.org>

Massive Hemorrhage

Replacement > half total blood volume (TBV) per hour or TBV < 24 hours

20

Transfusion: Massive Hemorrhage

- Notify Blood Bank immediately, send blood sample for type and cross
- Activate institutional pediatric massive transfusion protocol. Consider RBC : FFP : Platelets = 2:1:1 or 1:1:1
 - Use un-crossmatched O negative PRBCs and AB+ plasma until crossmatched blood available
 - Consider intraoperative blood salvage (e.g., Cell Saver)
- Obtain additional vascular access if needed
- Watch for hyperkalemia, if needed give calcium gluconate 60 mg/kg or calcium chloride 20 mg/kg while directly visualizing IV site (if peripheral)
- Warm the room
- Send labs/perform point of care testing q 30 min: CBC, platelets, PT/PTT/INR, fibrinogen, rapid TEG, ABG, Na, K, Ca, lactate
- Blood product administration:
 - Use 140 micron filter for all products
 - Use a blood warmer for RBC and FFP transfusion (NOT for platelets)
 - Consider use of rapid transfusion pumps
 - Monitor ABG, electrolytes, and temperature
- Consider TXA 10-30 mg/kg IV bolus then 5-10 mg/kg/h IV infusion
- When under control: call blood bank to terminate

Treatment

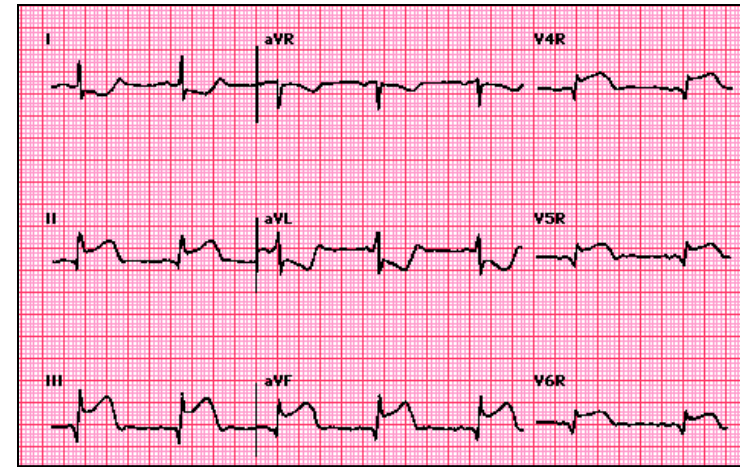
- HCT < 21% or Hgb < 7:
 - 4 ml/kg PRBC increases Hct by 3%
- Platelet count < 50,000 (< 100K for brain injury), rapid TEG-MA < 54mm:
 - 10 ml/kg apheresed platelets increases platelet count by 30 – 50k
- INR > 1.5 (or > 1.3 brain injury), rapid TEG-ACT >120 sec:
 - 10ml/kg plasma increases coagulation factors by 20%
- Fibrinogen < 100 mg/dL or rapid TEG-angle<66°, k value >120 sec:
 - 10 ml/kg cryoprecipitate increases fibrinogen by 30-50 mg/dL
- Refractory hemorrhage
 - Consider factor VIIa, up to 90 MICROgrams/kg

Treatment:

- Improve O₂ Supply:
 - Increase O₂ to 100%
 - Correct anemia
 - Correct hypotension
- Decrease O₂ Demand:
 - Reduce heart rate
 - Correct hypertension
 - Restore sinus rhythm
- Drug therapy (rarely needed in peds, consult a pediatric cardiac expert):
 - NitroGLYCERIN 0.5-5 MICROgrams/kg/min
 - Consider heparin infusion 10 Units/kg bolus, then 10 Units/kg/hour

Potential Causes:

- Severe hypoxemia
- Systemic arterial hypo- or hypertension
- Marked tachycardia
- Severe anemia
- Coronary air embolus
- Cardiogenic shock
- Local anesthetic toxicity



Recognition

- ST depression >0.5 mm in any lead
- ST elevation >1 mm (2mm in precordial leads)
- Flattened or inverted T waves
- Arrhythmia: VF, VT, ventricular ectopy, heart block

Diagnostic studies

- 12-lead ECG:
 - II, III, aVF for inferior (RCA)
 - V5 for lateral ischemia (LCx)
 - V2, V3 anterior ischemia (LAD)
- Compare to previous ECGs
- Request Pediatric Cardiology consult and echocardiogram

Initial Management

- Give 100% O₂ Call stat for inhaled nitric oxide (iNO) 20-40 ppm. Reduced O₂ saturation may not be immediate
- Consider stat TEE and ECMO
- Deepen anesthetic/sedation, consider fentanyl 1 MICROgram/kg or ketamine 0.5-1 mg/kg
- Administer muscle relaxant
- If poor perfusion, consider chest compressions early

Hypotension Management

- If hypotensive, give vasopressin 0.03 units/kg bolus, then:
 - To maintain perfusion:
Vasopressin 0.17-0.67 milliunits/kg/minute = 0.01 to 0.03 units/kg/hour
or
NOREPInephrine 0.05-0.3 MICROgrams/kg/min

Ventilation

- Ventilate with low airway pressures & long expiratory phase to maintain adequate tidal volume, avoid atelectasis and preserve FRC. Maintain normocapnia or mild hypocapnia. PEEP may worsen pulmonary hypertension

Further Management

- Administer isotonic fluid judiciously to achieve normovolemia and to reduce acid load, correct acidosis with sodium bicarbonate
- Maintain NSR and AV synchrony
- Temperature: ensure normothermia

Crisis Management

- If cardiac arrest occurs or is imminent, give epinephrine 1-10 MICROgrams/kg
- If cardiac arrest occurs, begin CPR and call for ECMO as CPR may be ineffective if no intracardiac communication

- Confirm ABCs: Airway, Breathing, Circulation
- Increase O₂ to 100%, consider intubation
- Place monitors: ECG, SpO₂, BP, EtCO₂
- Obtain IV access
- Stop local anesthetic infusion/injection
- Check glucose. If <60 mg/dL, give D25W IV:
 - <2 years: 4 mL/kg
 - ≥2 years: 2 mL/kg
- **Pick one:**

Consider:

- Causes: Hypoglycemia, hyponatremia, hypothermia
- Additional causes: Hypoxia, local anesthetic toxicity, increased ICP, hypotension, air embolism (go to relevant card)
- ABG/VBG and temperature monitoring
- Postop PICU

Preop/PACU/Natural Airway

- Prepare to immediately intubate if needed
- Give benzodiazepine IF available
 - IF IV access:
 - Midazolam or lorazepam or diazepam 0.1-0.2 mg/kg (MAX 20 mg) may give 2nd dose
 - IF NO IV access:
 - Midazolam intranasal or IM 0.4 mg/kg (MAX 20 mg)
- If seizures continue, go to **'Intraop/ Assisted Ventilation'** box on right

Intraop/Assisted Ventilation

- Maintain adequate ventilation
- Increase inhaled anesthetic to 1.5-2 MAC, or give propofol 2 mg/kg IV (**avoid** if on ketogenic diet) or midazolam 0.1 mg/kg IV (repeat up to 2x every 3 min, if needed)
- If movement could be dangerous, consider neuromuscular blockade and pausing surgery
- Create safer environment, if needed (e.g. removal from Mayfield pins)
- If seizure >6 minutes, consider anticonvulsants in consultation with ICU and neurology, following pharmacy infusion instructions:
 - Levetiracetam 50 mg/kg IV (MAX 4.5 g), then Fosphenytoin 20 mg PE/kg IV (MAX 1.5 g PE), then Valproic acid 40 mg/kg IV (MAX 3 g) after 10 min, if needed (for >10 years old)

- Watch for myocardial suppression, vasoplegia, or rhabdomyolysis: may be associated with poorly controlled or prolonged seizures
- If seizure ≥15 min, consult expert and see American Epilepsy Society Guidelines

- Call for defibrillator and code cart. Typically infant ≥ 220 bpm, child ≥ 180 bpm
- Place patient on backboard. Attach defibrillator pads
- Give 100% O₂, stop anesthetic agents, notify team, consider cardiology consult
- If NO pulse present: start CPR/PALS; go to 'Cardiac Arrest' card
- If pulse present: administer appropriate treatment (see table below)

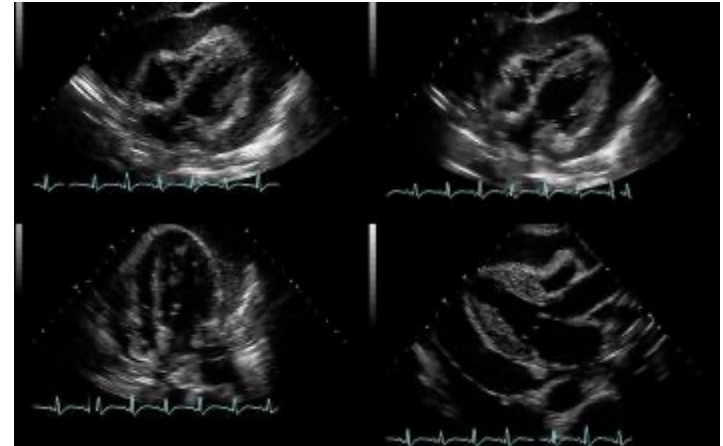
Treatment			
Narrow complex: p waves present before every QRS	SVT, tachyarrhythmia	Wide complex	Torsade de Pointes: polymorphic VT with prolonged QT
<ul style="list-style-type: none"> ▪ Probably sinus tachycardia ▪ Identify and treat underlying etiology 	<ul style="list-style-type: none"> ▪ Consider vagal maneuvers ▪ Adenosine: 1st dose 0.1 mg/kg IV, rapid push (6 mg MAX); 2nd dose 0.2 mg/kg IV (12 mg MAX) ▪ Synchronized cardioversion: 0.5-1 joule/kg, additional shocks @ 2 joules/kg 	<ul style="list-style-type: none"> ▪ Amiodarone 5 mg/kg IV bolus over 20-60 min OR ▪ Procainamide 15 mg/kg IV bolus over 30-60 min OR ▪ Synchronized cardioversion: 0.5-1 joule/kg, additional shocks @ 2 joules/kg 	<ul style="list-style-type: none"> ▪ Magnesium sulfate 25-50 mg/kg IV/IO (MAX 2 g) ▪ Lidocaine 1 mg/kg IV (MAX 100 mg) ▪ Sodium bicarbonate (for quinidine-related SVT) 1 mEq/kg IV ▪ Temporary pacing (see 'Bradycardia' card)

Signs & Symptoms

- Beck's Triad: muffled heart tones, distended neck veins, decreased systolic blood pressure
- Pulsus Paradoxus: cyclic inspiratory decrease in systolic BP of more than 10mmHg
- Electrical Alternans: cyclic alteration in magnitude of p waves, QRS complex & t-waves
- Typical presentation of acute tamponade = sudden hypotension, tachycardia & tachypnea; patient may be unable to lie flat

Diagnosis

- Echocardiography/ultrasound: diastolic compression or collapse of RA/RV, leftward displacement of ventricular septum, exaggerated increase in RV size with reciprocal decrease in LV size during inspiration



Treatment - imaging is key in deciding treatment

- Pericardiocentesis awake/local for large effusions prior to GA
- Surgical for postoperative tamponade (cause is often local collections of clotted blood)

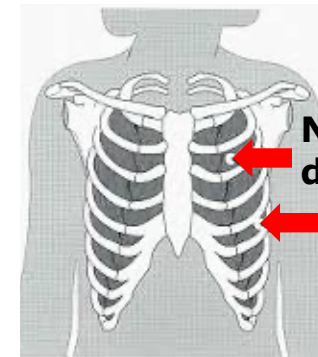
Anesthetic Considerations

- Progressive decrease in SV with an increased CVP → systemic hypotension → cardiogenic shock
- Goals: maintain sympathetic tone and CO via ↑ HR and contractility/fluid bolus prn
 - Induction: Ketamine (1-2 mg/kg IV), muscle relaxant
 - If CV collapse: EPINEPHrine 0.05-0.1 MICROgrams/kg IV bolus or infusion (0.01-0.1 MICROgrams/kg/min)
 - Access: Large bore PIV; arterial line ideal but should not delay treatment in hemodynamically unstable patient
 - Avoid: cardiac depression, vasodilation, ↓ HR; ↑ airway pressure (will ↓ venous return) so may need small tidal volumes or hand ventilation

Differential Diagnosis

- CHF, PE
- If pulsus paradoxus: respiratory distress, airway obstruction, COPD, PE, RV infarction

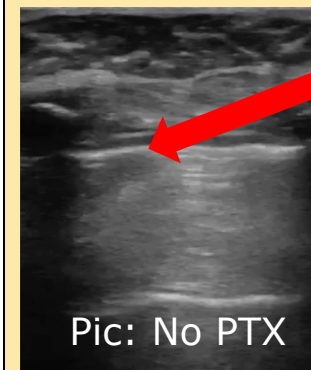
- Stop N₂O; increase O₂ to 100%
- Perform immediate needle decompression, then chest tube placement
- Needle decompression:
 - 2nd rib space superior to 3rd rib, mid-clavicular line
 - 14-16g angiocath for teens/adults
 - 18-20g angiocath for infants/children
- Secure airway with endotracheal tube
- Reduce positive ventilation pressure
- Consider CXR, lung ultrasound, transillumination to confirm diagnosis (see inset)
- Administer vasopressors for circulatory collapse
- Chest tube insertion
 - 5-6th intercostal space, mid-axillary line
- If no improvement in hemodynamics after a rush of air, consider:
 - Needle decompression of contralateral side
 - Presence of pneumopericardium
 - Scan both lungs with ultrasound or transillumination to evaluate for alternate side or insufficiently decompressed pneumothorax



Downloaded from:
http://www.uwhealth.org/images/ewebeditpro/uploadimages/5384_Figure_1.jpg

Lung Ultrasound Instructions

- High frequency probe, place longitudinally on chest, 2nd intercostal space. Slide probe downwards to observe pleural sliding



- If see pleural sliding, 100% positive predictive value no pneumothorax
- If no pleural sliding, consider pneumothorax, ARDS, fibrosis, acute asthma, pleurodesis

For All Reactions:

- Stop transfusion
- Disconnect donor product and IV tubing
- Infuse normal saline through clean tubing
- Examine blood product ID; determine correct pt
- Send product to Blood Bank
- Determine the type of reaction:

	Hemolytic	Non-Hemolytic	Anaphylactic
Signs	Hemoglobinemia, hemoglobinuria, DIC, ↓ BP, ↑ HR, bronchospasm	↓ BP, bronchospasm, pulmonary edema, fever, rash	Erythema, urticaria, angioedema, bronchospasm, tachycardia, shock
Treatment	<ul style="list-style-type: none"> ▪ Furosemide 1-2 mg/kg IV (MAX 40 mg) ▪ Mannitol 0.25-1 g/kg ▪ Support BP to maintain renal perfusion ▪ Maintain urine output at least 1-2 mL/kg/hour ▪ Prepare for cardiovascular instability ▪ Send blood and urine sample to laboratory 	<ul style="list-style-type: none"> ▪ Treat fever ▪ Treat pulmonary edema ▪ Observe for signs of hemolysis 	<ul style="list-style-type: none"> ▪ Support airway and circulation as necessary ▪ EPINEPHrine 1-10 MICROgrams/kg IV ▪ DiphenhydrAMINE 1 mg/kg IV (MAX 50 mg) ▪ MethylPREDNISolone 2 mg/kg IV (MAX 60 mg) ▪ Maintain intravascular volume

Set-up prior to patient arrival to OR:

- Assemble team and assign roles
- Estimate weight and prepare emergency drugs
- Warm the room
- Gather equipment:
 - Airway supplies
 - Line placement and monitoring devices
 - Fluid warmer/rapid infusion device
 - Code cart with programmed defibrillator
- Type and cross blood products. Activate massive transfusion protocol if indicated

On patient arrival to OR:

- Maintain c-spine precautions for transport
- Secure/confirm airway (often aspiration risk, unstable c-spine)
- Ensure adequate ventilation (maintain PIP < 20 cm H₂O)
- Obtain/confirm large-bore IV access (central or intraosseous if peripheral unsuccessful)
- Assess hemodynamic stability.
 - If hypovolemic, pre-induction fluid bolus recommended: 20 mL/kg LR or NS (repeat x 2) and/or 10 mL/kg RBCs or 20 mL/kg whole blood
- Arterial and central venous line placement if indicated
- Maintain normothermia
- Monitor and treat associated conditions
 - Anemia, coagulopathy, acidosis, electrolyte derangements
- Continuously assess for undiagnosed secondary and/or developing injuries, blood loss

MATERNAL CRISIS

- **ATTENTION:** This checklist is for **ADULT-SIZED** maternal patients **ONLY**
- Prepare for crystalloid and blood product resuscitation
- Obtain vascular access with 2 large-bore IVs
- Call Blood Bank to activate Massive Transfusion with PRBC:FFP:platelet in a 4:2:1 ratio. Ask blood bank to prepare next round when each round is picked up.
 - Give calcium chloride ADULT DOSE 200-500mg/Unit PRBCs, in separate line. Monitor for hyperkalemia
 - Consider giving tranexamic acid early
 - If refractory hemorrhage, consider fVIIa and cryoprecipitate or fibrinogen concentrate
- Give uterotonics
- Call for rapid transfuser or pressure bags
- Warm room, patient and fluids (NOT platelets)
- Send CBC, PT/PTT/INR, fibrinogen, calcium, K, ABG

Obstetric Interventions	Consider
<ul style="list-style-type: none"> • Intrauterine balloon • External uterine compression sutures • Uterine artery ligation • Hysterectomy 	<ul style="list-style-type: none"> • Arterial line • If awake, convert to general anesthesia • Embolization in IR • TEG/ROTEM monitoring

Treatment

ADULT MATERNAL Uterotonics:

- Oxytocin ADULT DOSE 3-5 Units rapid infusion, then start 40 Units slow infusion
- Methylergonovine (Methergine) ADULT DOSE 0.2mg IM **NOT IV**, may repeat in 2 hours (AVOID in HTN and pre-eclampsia)
- Carboprost (Hemabate) ADULT DOSE 0.25mg IM **NOT IV**, may repeat q 15 minutes up to 8 doses (AVOID in asthma, pulmonary hypertension)
- Misoprostol ADULT DOSE 800-1000 MICROgrams rectal

Hemostatics:

- Tranexamic acid ADULT DOSE 1g IV
- If low fibrinogen, give cryoprecipitate ADULT DOSE 10 units or fibrinogen concentrate
- If refractory hemorrhage, consider factor VIIa 90 MICROgrams/kg, up to 3 doses